Borates: Handbook of Deposits, Processing, Properties, and Use (2)
Garrett

Table 1.1 (*continued*)

Name (Group; form)	Formula	Molecular weight[b]; $\%B_2O_3$[c]; hardness; density; crystal system
25. Boracite (=Stassfurite) a. Low temp., β[c] b. High temp., α[d]	$Mg_3[B_3O_5]_2[BO_3]Cl$ $5MgO \cdot MgCl_2 \cdot 7B_2O_3$ $Mg_3B_7O_{13}Cl$	392.04; 62.16%; 7–7.5; 2.89–2.97; β orthorhombic, α cubic (>265°C)
26. Borax (=Tincal)	$Na_2[B_4O_5(OH)_4] \cdot 8H_2O$ $Na_2O \cdot 2B_2O_3 \cdot 10H_2O$ $Na_2B_4O_7 \cdot 10H_2O$	381.372; 36.510%; 2–2.5; 1.711–1.715; monoclinic
27. Borcarite	$Ca_4Mg(CO_3)_2[B_4O_6(OH)_6]$ $4CaO \cdot MgO \cdot 2CO_2 \cdot 2B_2O_3 \cdot 3H_2O$ $Ca_4Mg(CO_3)_2B_4O_9 \cdot 3H_2O$	545.92; 25.51%; 5; 2.77–2.79; monoclinic
28. Boromuscovite 29. 1M, 2M[4] (Mica)	$KAl_2Si_3BO_{10}(OH, F)_2$ End Member, $KAl_2Si_3BO_{10}(OH)_2$	384.13; 9.06%; —; 2.13–2.90 282.14; 9.11%; monoclinic
30. Braitschite	$12B_2O_3 \cdot 6(Na_2O, CaO) \cdot RE_2O_3 \cdot 6H_2O$ $(Ca, Na_2)_6RE_2B_{24}O_{45} \cdot 6H_2O$	—; typical 48.2%; —; 2.84–2.90; hexagonal
31. Braitschite-Ce[d]	$(Ca, Na_2)_7(Ce, La)_2B_{22}O_{43} \cdot 7H_2O$	1632.15; 46.92%; rhombohedral
32. Braunite, boron	$Mn_7O_9SiO_3 — Mn_7O_9BO_3$	587.37; 5.93%
33. Buergerite[f] (Tourmaline)	$NaFe^{+3}_3Al_6O_3(OH, F)_4[BO_3]_3Si_6O_{18}$ End Member, $NaFe^{+3}_3Al_6B_3Si_6O_{30}F^{g}$	1052.35; 9.92%; 7–8; 3.29–3.34; rhombohedral
34. Cahnite	$Ca_2[B(OH)_4]AsO_4$ $4CaO \cdot B_2O_3 \cdot As_2O_5 \cdot 4H_2O$ $Ca_2BAsO_6 \cdot 2H_2O$	297.92; 11.68%; 3; 3.06–3.18; tetragonal
35. Calciborite	$Ca[BO_3 \cdot BO]$ $CaO \cdot B_2O_3$ CaB_2O_4	125.70; 55.39%; 3.5; 2.88; orthorhombic
36. Canavesite	$Mg_4[B_2O_5](CO_3)_2 \cdot H_2O$ $Mg_2(CO_3)(HBO_3) \cdot 5H_2O^{d}$	258.90; 13.47%; —; 2.00; monoclinic
37. Cappelenite[d]-(Y)[g]	$(Ba, Ca, Ce)_3(Y, Ce, La)_3[(BO_3)_6Si_3O_9]$; $Ba(Ce, Y)_6B_6Si_3O_{24}F_2^{g}$ End Member, $BaY_6B_6Si_3O_{24}F_2$	1395.49; 14.97% (typical 16.9–17.2%); 6–6.5; 4.41; hexagonal (rhombohedral ?)[g] 1241.87; 16.82%
38. Carboborite	$MgCa_2(CO_3)_2[B(OH)_4]_2 \cdot 4H_2O$ $2CaCO_3 \cdot MgO \cdot B_2O_3 \cdot 8H_2O$ $Ca_2Mg(CO_3)_2B_2O_4 \cdot 8H_2O$	454.22; 15.33%; 2; 2.09–2.12; monoclinic
39. Caryocerite[j]	$(Ca, Na)_4(RE, Th, Ce)_6[(Si, B)O_4]_6F_2 \cdot 5H_2O$	—; (typical 1.50–4.70%); 4.5–6; 4.13–4.45; hexagonal
40. Chambersite (Boracite)	$Mn_3[B_3O_5]_2[BO_3]Cl$ $5MnO \cdot MnCl_2 \cdot 7B_2O_3$ $Mn_3B_7O_{13}Cl$	483.94; 50.35%; 7; 3.47–3.49; orthorhombic
41. Charlesite[d] (Ettringite)	$Ca_6(Al, Si)_2(SO_4)_2B(OH)_4(O, OH)_{12} \cdot 26H_2O$; End Member, $Ca_6Al_2S_2BO_9(OH)_{15} \cdot 26H_2O$	1164.91; 2.99%; —; 1.69 1236.28; 2.81%; rhombohedral
42. Chelkarite	$CaMg[B_2O_4]Cl_2 \cdot 7H_2O$	347.01; 20.06%; —; 2.94; orthorhombic
43. Chestermanite[e] (Ludwigite)	$Mg_2(Fe^{+3}, Mg, Al, Sb^{+5})O_2[BO_3]$ End Member, $Mg_2Fe^{+3}BO_5$	196.64; 17.70%; —; 3.76–3.80 195.27; 17.83%; orthorhombic
44. Chlorite, boron bearing (cf., Manandonite $2H_2$)[d]	$Li_2Al_4[AlBSi_2O_{10}(OH)_8]$ $Li_{1.25}Al_{4.66}B_{1.35}Si_{2.13}O_{10}(OH)_8^{g}$ End Member, $Li_2Al_5BSi_2O_{14} \cdot 4H_2O$	511.82; 6.80%; —; 2.53–2.89; monoclinic (triclinic)[g] 504.88; 9.31%
45. Chromdravite[d] (Tourmaline)	$NaMg_3(Cr, Fe^{+3})_6[BO_3]_3(Si_6O_{18})(OH)_4$ End Member, $NaMg_3Cr_6B_3Si_6O_{27}(OH)_4$	1120.39; 9.32%; —; 3.42 1108.84; 9.42%; rhombohedral
46. Clinokurchatovite[d] (cl., kurchatovite)	$Ca(Fe^{+2}, Mg, Mn)B_2O_5$ End Member, $CaMgB_2O_5$	186.73; 37.28%; —; 3.02–3.40 166.00; 41.94%; monoclinic
47. Colemanite (=Borocalcite)	$Ca[B_3O_4(OH)_3] \cdot H_2O$ $2CaO \cdot 3B_2O_3 \cdot 5H_2O$ $Ca_2B_6O_{11} \cdot 5H_2O$-I	411.09; 50.81%; 4.5; 2.42–2.43; monoclinic
48. Congolite (Boracite) (cl., ericaite)	$(Fe^{+2}, Mg, Mn)_3[B_3O_5]_2[BO_3]Cl$ $(Fe, Mg, Mn)_3B_7O_{13}Cl$	454.21; 53.65%; 7.5; 3.57–3.58; rhombohedral

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1130 U.S. Rt. 1.
Newcastle, Maine 04553
Tel: (207) 563-2299
Fax: (207) 563-2619

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Fillers are various inert materials that are added to resins for the purposes of cost reduction, modifying mechanical properties or enhancing thermal transfer. They may be organic or metallic in nature. Their relative hardness (or abrasivity) is considered in the design and configuration of all Sheepscot meter/mix and dispense systems as it pertains to the long term durability and reliability of wetted components. A range of materials are available to optimize each system for the application.

Moh's Hardness Scale. Named after Fredrich Mohs, a German mineralogist who introduced the scale in 1812. Hardness, in general, is determined by what is known as Mohs's scale, a standard which is mainly applied to non-metallic elements and minerals. In this scale, there are ten degrees or steps, each designated by a mineral, the difference in hardness of the different steps being determined by the fact that any member in the series will scratch any of the preceding members. The scale is as follows:

1	Talc
2	Gypsum
3	Calcite
4	Fluor spar
5	Apatite
6	Orthoclase
7	Quartz
8	Topaz
9	Sapphire
10	Diamond

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Following are commonly used fillers and their Moh's numbers:

Filler	Moh's
Talc	1
Calcium Carbonate (aka Limestone)	3
Aluminum Tri-Hydrate. (aka Hydrated Alumina)	4
Zinc Borate	4
Silica (aka Silicone Dioxide, Crystalline quartz)	7
Aluminum Oxide	9

Notes:
Talc and Calcium Carbonate are commonly used as extenders in resins and are considered to be non-abrasive.

Zinc Borate is used as a flame retardant to qualify for UL 94V-O rating. It is considered to be slightly abrasive.

Silica and Aluminum Oxide are often used to provide enhanced mechanical and/or thermal properties. They are considered to be highly abrasive.

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